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1550A

Strain Indicator Calibrator

-Instruction Manual-

MEASUREMENTS GROUP

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INSTRUCTION MANUAL

MODEL 1550A STRAIN INDICATOR CALIBRATOR

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Model 1550A Strain Indicator Calibrator

1.0 GENERAL DESCRIPTION

The 1550A Strain Indicator Calibrator is a passive instrument designed to simulate strain gage circuits for the purpose of statically calibrating the indicator or conditioner to which they would be connected. All bridge circuits can be simulated: quarter, half, or full bridges of both 120Ω and 350Ω.

Output selection is by three decades of push buttons, plus a reversing button, so that any strain up to ±99 900$\mu\epsilon$ can be selected in increments of 100$\mu\epsilon$; no range change or rewiring is necessary over this full range. The instrument is direct-reading in microstrain for full or half bridges, calibrated at GF=2.00.

Strain gage transducers can be simulated to an output of ±49.95 mV/V in increments of 0.05 mV/V.

Many calibrators for strain indicators employ a "star-bridge": four resistors are connected at a point with their open ends forming the corners of the "bridge". Strain is simulated by, in essence, placing shunts across adjacent corners of this "bridge". Clearly this arrangement does not represent the Wheatstone bridge for which the indicator was designed, positive strain cannot be properly simulated, it must always be used in the "full-bridge" configuration, and both input and output resistances change in an abnormal manner; all these considerations may affect the validity of the calibration data.

By contrast, the 1550A Calibrator is a true Wheatstone bridge where two arms change resistance (both positively and negatively) to simulate the theoretical action of a strain gage. It is thus a completely valid calibration, regardless of the indicator circuitry, including quarter- and half-bridge arrangements.

The instrument case is equipped with slip-hinges which will allow removal of the cover if desired. The cover will slide off with a firm sidewards force. However, it is highly recommended that the cover be attached, closed and latched when the instrument is not in use, to prevent unnecessary moisture and dirt from getting into the critical components.

2.0 SPECIFICATIONS

Accuracy:	0.025% of setting ±1$\mu\epsilon$ (0.0005 mV/V), max. Traceable to N.B.S.
Repeatability:	±1$\mu\epsilon$ (0.0005 mV/V), max.
Stability:	(0.001% of setting ±1$\mu\epsilon$)/°C, max.
Thermal emf:	0.5μV/V of excitation, max.
Bridge Resistances:	120Ω and 350Ω. Input resistance ±0.05%, max., from nonimal at all output settings. Output resistance ±0.05%, max., from nominal at "000" $\mu\epsilon$, −0.25% at ±99 900$\mu\epsilon$.

Circuit:	True ±ΔR in two adjacent arms (opposite signs), plus two fixed arms for bridge completion.
Simulation:	One active arm (quarter bridge). Half bridge, one or two active arms. Full bridge, two active arms.
Range:	Two active arms: 0 to ±99 900$\mu\varepsilon$ in steps of 100$\mu\varepsilon$ @ GF=2.00. 0 to ±49.95 mV/V in steps of 0.05 mV/V. One active arm: 0 to ±49 950$\mu\varepsilon$ in steps of 50$\mu\varepsilon$ @ GF=2.00.
Output @ 000:	50$\mu\varepsilon$ (0.025 mV/V), max.
Excitation:	To meet accuracy and repeatability specifications: 120Ω: 0 to 10V ac or dc. 350Ω: 0 to 15V ac or dc. Maximum permissible: 120Ω: 25V ac or dc. 350Ω: 30V ac or dc.
Environment:	Temperature: 0° to +120°F *(−18° to +49°C).* Humidity: Up to 95% RH, non-condensing.
Size:	8-1/4 W x 5-3/4 H x 7-3/4 D in *(210 x 145 x 195 mm)*
Weight:	4.8 lb *(2.2 kg)*

3.0 FUNCTIONAL DESCRIPTION

3.1 Binding Posts

Two groups are provided, one for 120Ω and one for 350Ω simulation. The active half bridge is between P+, S− and P−. A fixed resistor is between each P post and each S+ post; these form a half bridge if the shorting link at S+ is closed. The GND post provides a convenient chassis ground connection.

3.2 CIRCUIT Push Buttons

These buttons connect the ΔR network to the selected binding post group thus simulating strain in the P+/S−/P− half bridge. (Without the proper circuit button selected, the bridge will be unbalanced some 48 000$\mu\varepsilon$.)

3.3 POLARITY Push Buttons

These buttons select the polarity of the unbalance (ΔR) selected by the MICROSTRAIN push buttons.

3.4 ±ZERO Adjustments

These trimpots (one each for 120Ω and 350Ω) trim the networks to eliminate zero-crossing errors (that is, so that the outputs at "+000" and "−000" are identical).

3.5 MICROSTRAIN Push Buttons

Three rows of ten buttons select the desired output to be simulated, the output being the total of the three buttons selected; it is direct-reading in microstrain (assuming both active arms are in use).

4.0 INDICATOR CALIBRATION

While the following instructions explain proper use of this instrument in detail, the brief instructions inside the lid will normally be adequate for subsequent use.

4.1 CONNECTIONS

Choose the circuit arrangement desired, with regard to resistance per arm (120Ω or 350Ω) and bridge configuration (see Figure 1). The GND post should be connected to the system ground (normally the strain indicator chassis) to minimize the effects of electrical noise pick-up. Place the S+ shorting link as shown and connect the leads to the indicator. For use with the V/E-20A, it is normally recommended that the P and S connections be transposed in the interconnection (i.e., S− of the 1550A be connected to P− of the V/E-20A, P− to S−, etc.).

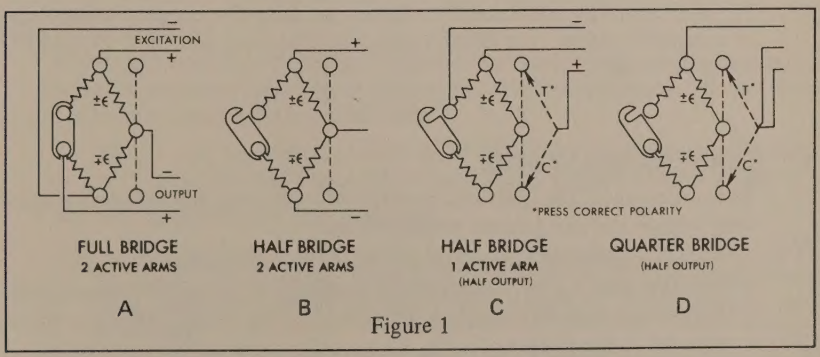

Figure 1

4.1a Full Bridge:

With the indicator connected as shown in Figure 1A (note that S+ shorting link must be closed), the output at S− will be exactly linear regardless of type excitation. Linearity is achieved since the total resistance from P+ to P− is constant as strain is simulated. It is the conventional arrangement, but note that the entire output is at S−; S+ is inactive with simulated strain.

An alternate use is to interchange the excitation and output leads to the indicator (i.e., positive excitation at S+, etc.). Now the output appears at *both* signal leads (binding posts marked P+ and P−) with opposite signs. This arrangement is precisely linear with constant current excitation; under constant voltage excitation the theoretical nonlinearity cannot even be detected over most ranges of use (0.25$\mu\epsilon$ at 10 000$\mu\epsilon$, or 0.00012 mV/V at 5 mV/V). This arrangement is thus recommended when calibrating transducer indicators.

4.1b Half Bridge:

The full bridge must be "opened" by opening the link at the S+ binding posts. In the normal arrangement (Figure 1B) both arms are active in opposite directions; since the resistance between the excitation binding posts is constant, output will be linear. Occasionally it may be desirable to check the indicator with only one active arm; in this case use the arrangement shown in Figure 1C, but note that a somewhat nonlinear display would be expected in most indicators since the bridge resistance changes somewhat as strain is simulated.

4.1c Quarter Bridge:

This arrangement (Figure 1D) simulates a single active strain gage where the balance of the bridge exists within the indicator. To essentially eliminate zero shift due to the temperature effects on the leadwire, the three-wire circuit shown should be used; for connections to the indicator refer to the instructions for that indicator. When changing polarity, the appropriate binding post must be utilized in addition to pressing the desired polarity button. To simulate tension or a positive output, the QB (T) post would be used with the +POLARITY button pressed. To simulate compression or a negative output, the QB (C) post would be used with the −POLARITY button pressed.

4.2 LEADWIRE RESISTANCE

The resistance of the leadwires between the calibrator and indicator is somewhat critical and can produce several effects:

a. Reduced calibrator output (usually called leadwire desensitization).
b. Unstable zero due to changes in lead resistance with ambient temperature.
c. Span errors when the indicator is "calibrated" by shunt-calibration of arms external to the indicator.

All the above effects are proportional to the ratio of the lead resistance to the gage (or bridge arm) resistance. Using relatively heavy leads, such as AWG 18 [0.0403 in *(1.024 mm)* diameter] will minimize errors; this is especially important when using the 120Ω circuit. However, if the purpose is to simulate an actual gage or transducer installation, use leadwires of the same size and length as would be used in the actual installation.

Good zero stability with temperature requires complete symmetry in the total bridge. To achieve this with the quarter or half bridge, use nearly identical wires for all leads (size and length) and keep them grouped together to minimize temperature differentials.

Leadwire desensitization should be considered in almost all bridge circuits; since the effect varies somewhat among indicators, it is usually discussed in the companion instruction manual, which should be consulted. Generally the error would be below 0.02% using a 3 ft *(1 m)* length AWG 18 , although the error may be several times greater where shunt calibration is employed.

4.3 CALIBRATOR SET-UP

Press the CIRCUIT button corresponding to the binding post group in use (120Ω or 350Ω).

Press the "0" button in each MICROSTRAIN decade.

Apply bridge excitation. Excellent stability will be achieved with normal excitations (up to 10V on 120Ω or 15V on 350Ω). Maximum permissible excitation (25V and 30V, respectively) may produce some warm-up drift; readings should not be recorded until stable, which may take up to a couple minutes at each selected output under extreme conditions.

If it is anticipated that readings will be taken through zero (that is, both POLARITY buttons will be used), check that "+000" and "–000" both yield the same reading. If not, adjust ±ZERO slightly to achieve this.

4.4 INDICATOR SET-UP

Where an initial zero or bridge balance control is provided on the indicator, it would be normal practice to set this to achieve a zero reading so that data need not be corrected for initial offset.

> NOTE: An unbalance of up to 50$\mu\epsilon$ (0.025 mV/V) can be encountered with the 1550A Calibrator where no indicator balance control is used.

Set the indicator scale factor as desired.

(a) A strain indicator would usually be set for a gage factor of exactly 2.000 to achieve direct-reading calibration. If it is set for any other gage factor, data reduction will be necessary (see paragraph 4.5a). Assume *one* active gage.

(b) A transducer indicator may read directly in mV/V, percent input for a fixed or settable span, or it may read directly in engineering units (pounds, newtons, etc.) for a selected transducer. Any indicator above can be accurately calibrated with the 1550A, although some simple data reduction is generally necessary (see paragraph 4.5b). Some special cases exist such as a percent instrument set for 0.5 or 5 mV/V span, where "data reduction" is simply decimal point placement; while this makes

calibration simple, it may not represent the parameters over which the instrument is normally used and thus may not be an entirely valid check of the instrument.

4.5 DATA REDUCTION

4.5a Strain Indicator:

(a) If set for GF=2.000 and using two active arms in the calibrator, no data reduction is necessary: the indicator reading and calibrator can be directly compared.

(b) If set for GF=2.000 but using only one active arm in the calibrator, the indicator should read *half* the calibrator setting. Some nonlinearity in the indicator would be expected at the higher readings.

(c) If set for any gage factor other than 2.000, the following relationship applies:

$$\text{Ideal indicator reading} = \text{calibrator setting} \times \frac{N}{GF}$$

where GF = indicator gage factor setting

N = number of active arms used in calibrator

again, where N = 1, some nonlinearity would be expected.

4.5b Transducer Indicator (full-bridge input, two active arms):

In all the expressions below, "calibrator setting" is the setting of the decade buttons in microstrain. For example, if buttons 0-2-5 are selected, the "calibrator setting" would be 2500.

(a) mV/V Readout:

$$\text{Ideal mV/V reading} = \text{calibrator setting} \times \frac{1}{2000}$$

(b) Percent Readout:

$$\text{Ideal percent reading} = \text{calibrator setting} \times \frac{1}{20 \times k}$$

where k = full-scale output of transducer in mV/V.

(c) Direct-reading in Engineering Units.

$$\text{Ideal reading} = \text{calibrator setting} \times \frac{T_R}{2000 \times k}$$

where T_R = rated input to transducer in engineering units (pounds, newtons, etc.)

k = transducer output in mV/V at rated input.

4.6 1550A AS PRECISION ATTENUATOR

The 1550A Strain Indicator Calibrator is simply a passive network in a Wheatstone bridge configuration with an output/input ratio from 0 to 0.05 in 1000 linear steps. It therefore has application where large but precise attenuations are required.

For example it can be used to check the linearity of low-input instruments. If the 1550A is excited (at P+ and P–) with a stable and accurate 2V source, outputs of 0 to 99.9 mV can be generated between S+ and S– in increments of 0.1 mV. The step resolution will always be one part in 20 000 of the excitation.

The user is cautioned on two limitations:

(a) The output at "000" may be up to half the value of the smallest step (0.0025% of excitation) unless some external means are provided to balance the 1550A. This could be a 10k potentiometer across P+ and P– with the slider connected to S+ via a resistor of some 500kΩ; the pot would be set as required to achieve zero output.

(b) Either the power supply output must be floating (not grounded) or the instrument must be able to accept a differential input, since the level at the output will be half the excitation voltage, measured from the P– binding post.

5.0 SERVICING

The 1550A Strain Indicator Calibrator is a completely passive device consisting of only switches and precision resistors. Routine or preventive maintenance is not required.

In view of the intended purpose of this instrument as a "standard", it should be accorded more than the normal care in handling. If required, the cover will slide off the slip-hinges with a firm sideways force. However, when the instrument is not in use, it is recommended that the cover be attached, closed and latched. Avoid storing in areas of unusual environment, such as extremes of temperature, high humidity, or areas which may contain corrosive atmospheres.

5.1 RESISTOR REPLACEMENT

Should it be necessary to replace any resistors in the networks, it is strongly suggested that such replacements be obtained from Measurements Group to maintain the superior quality of these resistors with special regard to stability with time and temperature. All resistors have a tolerance of 0.01 or 0.02%.

A complete schematic of the 1550A is shown on page 11; this is for reference only as most resistor values have been rounded to the nearest 0.1Ω since the precise values used may not represent theoretical values to allow for copper resistance in the circuit path.

WARRANTY

Measurements Group, Inc., warrants all instruments it manufactures to be free from defect in materials and factory workmanship, and agrees to repair or replace any instrument that fails to perform as specified within one year after date of shipment. This warranty shall not apply to any instrument that has been:

i) repaired, worked on or altered by persons unauthorized by the Measurements Group in such a manner as to injure, in our sole judgment, the performance, stability, or reliability of the instrument;
ii) subjected to misuse, negligence, or accident;
or
iii) connected, installed, or used otherwise than in accordance with the instructions furnished by us.

At no charge, we will repair, at our plant, or an authorized repair station, or at our option, replace any of our products found to be defective under this warranty.

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The Measurements Group's sole liabilities, and buyer's sole remedies, under this agreement shall be limited to the purchase price, or at our sole discretion, to the repair or replacement of any instrument that proves, upon examination, to be defective, when returned to our factory, transportation prepaid by the buyer, within one year from the date of original shipment.

Return transportation charges of repaired or replacement instruments under warranty will be prepaid by the Measurements Group, Inc.

The Measurements Group is solely a manufacturer and assumes no responsibility of any form for the accuracy or adequacy of any test results, data, or conclusions which may result from the use of its equipment.

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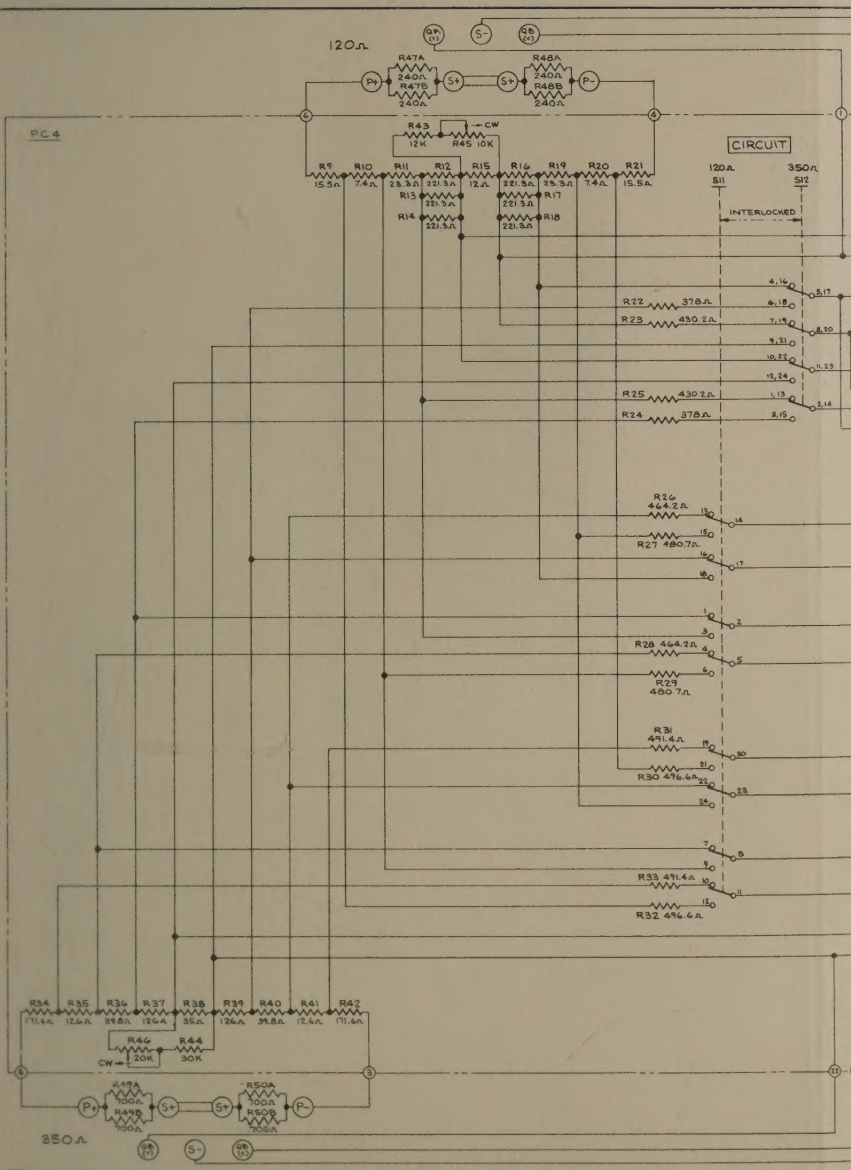

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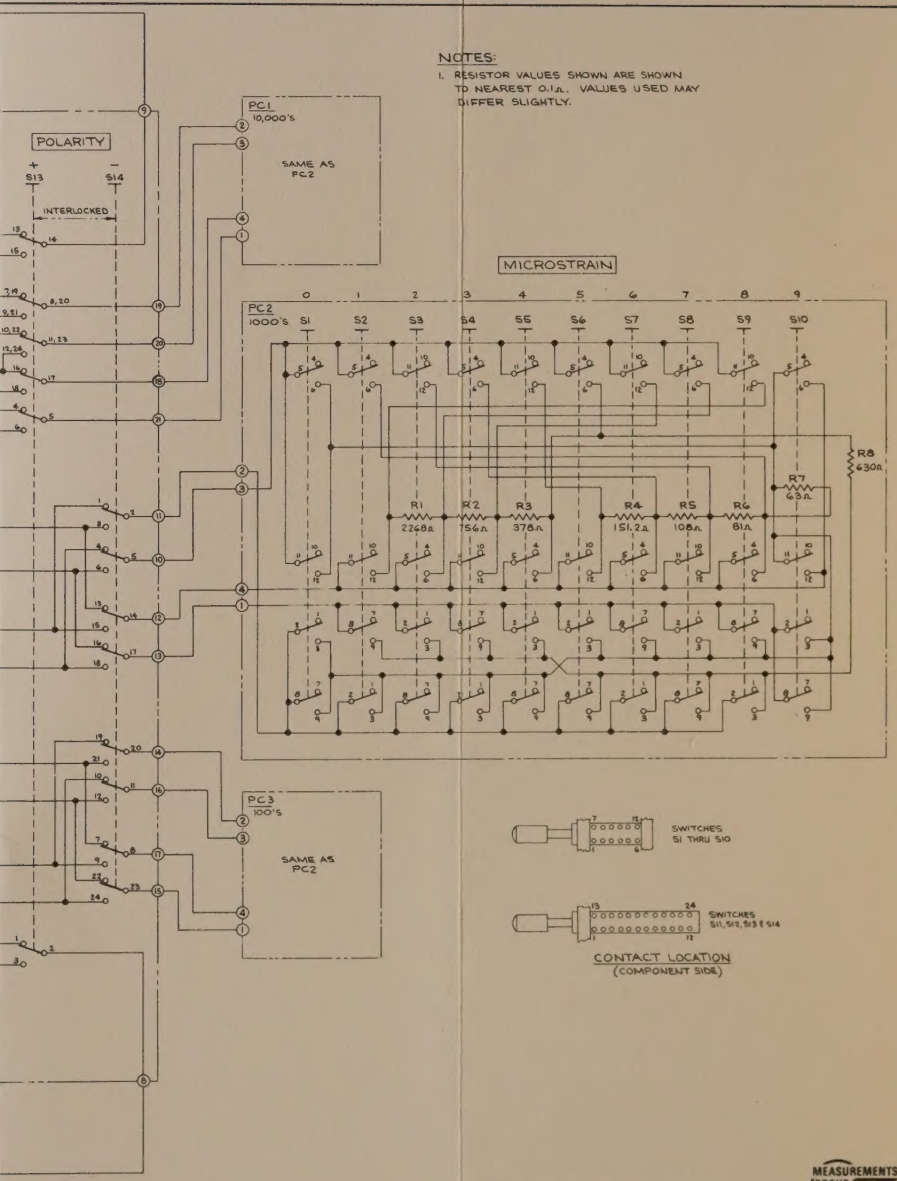

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